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SOME DIPTERA OF MEDICAL INTEREST IN THE SUDAN REPUBLIC

By D. J. Lewis[1]

(*Scientific Staff, Medical Research Council*)

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I. Introduction

This paper deals mainly with some flies that are received for identification from public health officers or otherwise come to the attention of the medical entomologist. They include flies which bite man or animals, cause annoyance by swarming, may contaminate food, or act as scavengers, and some which are related to harmful ones.

The positions of localities can be found on standard maps or on maps in previous papers by the writer which are mentioned below. The initials in brackets after certain records are those of collectors whose names appear in the acknowledgments.

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II. Insects of Medical Interest Described under Families

1. *Nematocera*

Psychodidae : Psychodinae

Telmatoscopus albipunctatus (Williston) is a large conspicuous species (Quate, 1952) which, according to Tonnoir (1939), was originally Ethiopian and is now cosmopolitan except for parts of the temperate regions. Cuthbertson (1936) found its larvae in water from sewage beds, and its breeding habits have been reviewed by Quate (1952). Adults have been found in pit latrines at Li Yubu and Raffile, and in a steamer at Tonga. *Psychoda alternata* Say, another widespread species, has been found at Khartoum (H. W. B.).

Psychodidae : Phlebotominae

Thirty-seven species and 13 varieties of sandflies are known in the Sudan (Lewis and Kirk, 1954). Their distribution has been studied in relation to that of kala azar (Kirk, 1956), oriental sore and sandfly fever (Lewis and Kirk, 1954).

Culicidae

One hundred and fifty-six species, two subspecies and seven varieties of Culicidae are found in the Sudan (Lewis, 1956 *b*, *c*). *Dixa lunata* Edwards, which occurs on Jebel Marra, is now known to be widely distributed in Africa (Freeman, 1956). The previous record of *Anopheles gambiae* Giles from Jebel Haraza refers to a place of the same name near Abu Tabar (W. R.).

Chironomidae

Species of *Tanytarsus* are an important pest at Khartoum and Wadi Halfa, where they appear in vast clouds in the dry season (Lewis, 1957). It would be very difficult and costly to control them completely and a policy of defence may prove more practicable than one of destruction.

Ceratopogonidae

Most of the Sudan records of this family have been published by Macfie (1947) who recorded 34 species, including 12 of *Culicoides*, and remarked that most of them were widely distributed in the Ethiopian Region. Kieffer (1921) recorded three species of *Culicoides*. Additional notes are as follows: *Holoconops kerteszi* (Kieffer), a notorious blood-sucker well known in the Mediterranean area (De Meillon and Hardy, 1953), found on Kamaran Island in the Red Sea (recorded simply as Kamaran by Macfie); *Forcipomyia* spp., Muklei and Rumbek; *Culicoides austeni* Carter, I. and M., Li Rangu (Sudan Medical Service Report for 1937); *C. grahami* Austen, Li Yubu; *C. inornatipennis* C., I. and M., Bandula and Fangak; *C. kingi* Austen, Khor Arbaat (Austen, 1912), *C. milnei* Austen, Malek (Austen, 1912); *C. neavei* Austen, Jambo (mosquito net), Mvolo (bit, Austen, 1912); *C. pycnostictus* C., I. and M., Rahad; *C. schultzei* (Enderlein), probably from Getti Bridge; *C. similis* C., I. and M., Katcha (Macfie, 1947).

Forcipomyia egypti M. has been observed sucking water-melon juice and apparently taking up fluid from a dead guinea-pig. An addition to the many records of Ceratopogonids attacking insects (Varley, 1948; Gad, 1951; Thiene-

mann, 1954; Downes, 1955; Forattini and Lane, 1955) is that of a species of *Forcipomyia* found biting larvae of the Sphingid moth, *Nephele comma* Hopffer, on a *Gardenia* bush at Rumbek (16.xii.52, C. B. O'M. O.); many midges were present and 12 were identified.

Midges are occasionally seen biting people and donkeys at Wad Medani in the winter, and are known to attack people around Li Rangu and in some other areas. In spite of the vast size of the Sudan, however, biting midges have very seldom been reported to be a nuisance except, at times, round Lagawa and other areas of the Nuba Hills. The species concerned there (taken on a donkey at Lagawa, 13.viii.45, *F. B.*) are *Culicoides milnei*, *C. pallidipennis* C., I. and M. and *C. schultzei*, and are known as *gim* (pronounced *geem*) flies. I have been informed by Mr. T. R. H. Owen that the gim is well known throughout southern Kordofan, occurring as far north as 12° or beyond during the rains and dying away by early November; and that the flies are active mainly at night when they work their way into the eyes, ears and noses of domestic animals and sometimes cause death. According to Dr. F. el Bushra the gim at Lagawa are said to fly in swarms and attack sheep, horses, donkeys and cattle; the sheep are said to die on the night they are attacked and the horses to develop haematuria and die after two or three days. Gim are said to prevent animals from using the Kadugli-Talodi road at times and to make tethered beasts break loose. At Lagawa a man was reported to have died as a result of sleeping out of doors with his head uncovered and being bitten by gim flies. The exact effect of midge-bites in this rather remote area has not been studied, but the above-mentioned reports are quoted to emphasise the very bad local reputation of these flies.

The virus of African horse sickness is probably transmitted by *Culicoides* (Du Toit, 1944). Balfour and Archibald (1908) and Williams (1913) reported an outbreak of this disease at Dilling in Kordofan in November and December 1908, and the annual reports of the Sudan Veterinary Service show that it was important and widespread in the central Sudan about as far north as 16°, and beyond this latitude in the southern Red Sea Hills. Carpano (1930) and Kamal (1948) reported that it spread northward into Egypt. The disease was formerly believed to be transmitted by mosquitoes (Balfour, 1909*b*, 1910, and others), so that, as veterinary reports indicate, there was considerable surprise when many cases occurred in relatively dry years, when there were fewer mosquitoes than usual and few cases occurred in very wet years. Horse sickness used to break out in the dry season at Wad Medani, when there were few mosquitoes, the first cases being reported between 20th October and 10th November; the incidence was high for a month, decreased till the end of January, increased again in February, and cases continued till early March at the latest. Vaccination was introduced in 1935, and brought the disease under control. Midges have not been studied in relation to horse sickness in the Sudan, but their seasonal incidence at Wad Medani and the report of plagues of midges at Lagawa, which is near the old outbreak centre of the disease at Dilling, support the theory of transmission by these insects.

Acanthocheilonema perstans, the nematode parasite of man which is probably transmitted by *C. austeni* and other members of the genus, is widespread in the southern Sudan (Bryant, 1935; Cruickshank, 1936; Woodman and Bokhari, 1941; Woodman, 1948; Abbot, 1950).

Simuliidae

Lewis (1956*a*) recorded 21 species and two other forms from the Sudan. They include *Simulium damnosum* Theobald, an important vector of human onchocerciasis which occurs along many of the southern rivers, and *S. griseicolle* Becker, a serious pest of man and animals in the Northern Province.

Mycetophilidae and Scatopsidae

Bohart and Gressitt (1951) found larvae of the Mycetophilid genus *Sciara* in fungus in manure, and those of *Scatopse*, the principal genus of the Scatopsid dung midges, in human faeces. *Sciara hirtilineata* Brunetti and *Scatopse fuscipes* Meigen, a nearly cosmopolitan species, have been found at Wadi Halfa, the former in imported potatoes (A. H. H.).

2. *Brachycera*

Tabanidae

Seventy-six species are known from the Sudan, 70 recorded by Lewis (1952, 1953), five more by Oldroyd (1952, 1957), namely *Sphecodemyia infuscata* Oldroyd, *Philoliche rüppellii* Jaenicke, *Atylotus deminutus* Oldroyd, *Haematopota corsoni* Carter and *H. pallidipennis* Austen, and in addition *H. wittei* Oldroyd. Reid (1957) has compiled additional information. Some new unpublished localities are as follows: *Pangonia magrettii* Bezzi, *Ancala latipes* (Macq.), *Atylotus agrestis* (Wied.), *A. fuscipes* (Ricardo), *Tabanus taeniola* P. de B. and *H. taciturna* Austen from Wad en Nail (W. S. R.); *H. wittei* from Unwich (E. T. M. R.). Hinton (1955) described some features of larvae of *T. kingi* Austen from the Sudan.

The following notes are additional to the previous account (Lewis, 1953) of Tabanids as a pest and of their effect on the distribution of the human population. Torit (C. V. P.) and the El Melemm area (Howell, 1951 : 243) are among localities where Tabanids can be abundant and troublesome, and the northern limit of the Tabanid belt varies from year to year; near Tendelti, for instance, it can fluctuate some 40 miles (G. H. B.). Paul (1954) considered that the need to migrate away from the "fly" each rainy season probably brought the Fung people from Sennar into contact with the Gezira Arabs in the sixteenth century, and so led to an alliance which overthrew the Kingdom of Soba and founded that of Sennar.

Asilidae

According to Balfour (1909*a*) a species of Asilid was said to bite man at Nahud, but with little harmful effect. This observation has not been repeated, but Gaud and others (1956) refer to an Asilid biting animals in Morocco.

3. *Cyclorrhapha*

(a) *Aschiza*

Phoridae

Patton (1922) figured the larva of *Diploneura* (*Dohrniphora*) *cornuta* Bigot (which is rather like that of *Fannia*) and its pupa under the name of *Aphiochaeta rufipes* Meigen, and Schmitz (1951 : 242), who stated this to be a

misidentification, figured the prothoracic horn of the pupa. According to him (1929, 1951) *D. cornuta* is cosmopolitan in both hot and temperate regions, and Brues (1925) points out that such species are readily spread by commerce. Several species of *Dohrniphora* regularly develop in the dead bodies of insects and snails, the egg being deposited after the death of the host, and *D. cornuta* is known to breed in dead snails and sour milk (Brues, 1925) and in human faeces (Bohart and Gressit, 1951). This species has been found breeding in pit latrines and dead snails at Khartoum.

Megaselia scalaris (Loew), which is figured by Smart (1956), is a circumtropical species extending into temperate regions and breeds in decaying material (Bohart and Gressitt, 1951). Larvae of *Megaselia* have been found in dead snails and horse dung at Khartoum, in a trench latrine at Suakin, and in a dead guinea-pig at Wad Medani; *M. scalaris* has been bred from imported potatoes at Wadi Halfa (A. H. H.).

Examples of these two genera are illustrated by Colyer and Hammond.

Syrphidae

Species of *Eristalis* found breeding in dirty water are occasionally received for identification.

At Khartoum North *Eumerus obliquus* was one of the commonest species breeding in pit latrines with semi-liquid contents, but, like several other flies with similar breeding habits, it was rarely seen in the adult stage. Its breeding habits are more like those of *Syritta* than of those species of *Eumerus* which breed in bulbs (Coe, 1953). The general appearance of a member of the genus *Eumerus* is shown in figures by Efflatoun (1922), Brunetti (1923) and Hodson (1927). *E. obliquus* Fabricius is easily recognised by the characters listed by Bezzi (1915), and has a larva of the short-tailed saprophagous type figured by Hodson (1931) and Heiss (1938). According to Bezzi, it is widely distributed in the Ethiopian Region where members of this genus are particularly numerous. In the Sudan *E. obliquus* is known from Atbara (pit latrine), Delami, Heiban, Khartoum, Omdurman, Soba, Talodi and Wad Medani (pit latrines and sap-hole in a tree). Other species of *Eumerus* found in the Sudan are *E. strigatus* Fallén, bred from Egyptian onions at Wadi Halfa, and *E. vestitus* Bezzi, which was taken at Ezeirgab and, according to Efflatoun (1922), is found with the closely allied *E. obliquus* in West Africa.

Larvae of *Syritta* are also short-tailed and some breed in human excreta (Coe, 1953). *S. fasciata* Wiedemann is known from Delami and Shambat, *S. rubrifemur* Hull from Jebel Marra, and *S. spinigera* from Tokar.

(b) *Schizophora Acalypterae*

Gasterophilidae

Gasterophilus haemorrhoidalis L. (of which Zumpt and Paterson, 1953, give *G. flavipes* Olivier as a synonym), a Holarctic parasite of the horse, has been found at Dueim, Khartoum (Séguy, 1928), Kurmuk (donkey), Renk, Suakin and an unspecified locality (stomach of donkey, Neveu-Lemaire, 1938, Patton, 1931). *G. intestinalis* Degeer, a cosmopolitan parasite of the horse (Zumpt and Paterson, 1953), has been found at Aweil, Hillet Gali, Gallabat, Khartoum, Kurmuk, Malakal, Melut, Nasir, Renk, Sheraya, Talodi and Wad

Medani. *G. veterinus* Clark is an almost cosmopolitan parasite of the horse according to Zumpt and Paterson, and *G. albescens*, which they regard as a pale form of it, has been bred from horse dung at Wad Medani (R. C. M.–D.).

Otitidae

Chrysomyza aenea (F.), which has been found in fly traps at Wad Medani, is a metallic green fly with a larva which superficially resembles those of house-flies (Reid, 1953). It is widely distributed in the world and contaminates food on Guam Island (Bohart and Gressitt, 1951). *C. africana* Hendel is known from Bauga, Darmali and Wadi Halfa. *C. demandata* (F.), a dark green fly which is illustrated in colour by Colyer and Hammond (1951), is widely distributed (Patton, 1931) and in the Sudan is known from Darmali, Kamlin, Khartoum, Mvolo, Sennar, Shendi, Soba, Wadi Halfa, Wad Medani, Wau and Zeidab. It was been bred from compost pits, horse dung and stored onions, and the adults are often caught in fly traps and have been seen on human faeces. *C. smaragdina* Loew is known from El Fasher, Li Rangu, Malakal, Talodi and Wadi Halfa, and has been bred from compost and rotting millet stalks. Many adults of *Elassogaster vanderwulpi* Hend. were found on a latrine bucket out of doors at Wad Medani.

Piophilidae

Piophila casei (L.), the almost cosmopolitan Cheese Skipper, has been bred from bacon, cheese and salted fish at Khartoum but has not been found elsewhere in the Sudan.

Trypaneidae

The larvae of many species feed on growing or ripe fruit, and may be eaten by people or be mistaken for house-fly larvae. *Dacus ciliatus* Loew has been bred from marrows at Wad Medani, and *D. longistylus* Wied., which is often seen on *Calotropis* bushes, has been bred from rotting oranges. Trypaneid larvae were received from Khartoum (M. A. H.) where they had been vomited by a person who had probably eaten them with fruit.

Lonchaeidae

Lonchaea plumosissima Bezzi, a widespread shiny black species (Bezzi, 1918, 1920), was found breeding in a pumpkin at Kagelu, and *L. laevis* Bezzi in a melon at Wad Medani. *L. aristella* Becker bred in decayed millet stalks at Khartoum and Shendi, *L. durae* Hendel has been taken at Khartoum and Shendi, and *L. gibbosa* Meijere, an Oriental species (Bezzi, 1918), at Kadugli, Wad Medani (on *Acacia* attacked by Coccids, *Pulvinaria* sp.) and Zeidab. *L. aurea* Macq. is a widely distributed (Czerny, 1934) distinctive green species (Curran, 1928; Malloch, 1930), and much resembles a species figured by Colyer and Hammond (1951). It is known in the Sudan from Khartoum, Shambat, Wad Medani and Zeidab, and has been bred from aubergines, marrows, rotting melons, rotting tomatoes and rotting cotton bolls.

Sepsidae

Saltelliceps niveipennis Becker, which occurs in the tropics of the Old World (Hennig, 1949) and in Egypt where it commonly breeds in cow dung (Hafez, 1948), has been found breeding in cow dung at Khartoum (where *S. robusta* Duda also occurs) and Wad Medani.

Braulidae

Braula caeca Nitzulescu has been found on honey-bees in Khartoum.

Ephydridae

Bohart and Gressitt (1951) found that a species of *Chlorichaeta* behaved as an "eye fly". *C. albipennis* Loew has been found at Khartoum and Umm Kedada, and *C. tuberculata* Becker on a sore on a camel at Khartoum (H. W. B.). A species of *Allotrichoma* breeds in pig droppings (Bohart and Gressitt, 1951), and larvae of *A. perspiciendum* Becker have been taken in refuse beside the river at Wadi Halfa. *Discocerina* sp., probably *quadripectinata* Becker, has been found on a stink-horn fungus, *Phallus* sp., at Wad Medani.

Discomyza incurva Cresson, which is rather like a species that breeds in snails in Europe (Colyer and Hammond, 1951 ; Séguy, 1950), occurs at Kassala and at Flamingo Bay near Port Sudan (Cresson, 1939) and in Ethiopia (Soika, 1956). It has been found breeding in large numbers in drying mother-of-pearl molluscs, *Trochus* sp., at Flamingo Bay, where the adults caused annoyance by crawling on people's faces. There is also a "*Trochus* fly" in the ports of Queensland but it is a Phorid (Taylor, 1938).

Gymnopa albipennis Loew is a small shiny black fly known from Egypt and the Canary Islands (Becker, 1926), and the Sudan. It has been found at Ain Fara, Erkowit (settling on meat and on human skin), another place in Kassala Province (on cattle), Khartoum (some on human sweat, many on camel sore, H. W. B.), Khartoum North (many adults on dead fish at refuse dump) and Wad Medani (on recently killed goat).

The following three species belong to genera, members of which were found associated with faecal material by Bohart and Gressitt (1951): *Paralimna nubifer* Cresson was found at Nagishot, *Actocetor margaritatus* Wied. at Khartoum and Wad Medani and on Jebel Marra, and *Brachydeutera argentata* Walker at Duani.

Borboridae

The larvae of all species of this family appear to be scavengers (Richards, 1930). The most numerous dung-breeding insects in Egypt belong to this family, and a species of *Leptocera* breeds in cow dung near Wad Medani.

Drosophilidae

Drosophila ampelophila Loew (*melanogaster* Meigen) has been found at Juba, Kadugli, Kajo Kaji (bred from fallen mangoes), Keilak, Khartoum, Tokar, Wadi Halfa and Wad Medani. *Zaprionus vittiger* Coquillett, which is widely distributed in the Sudan, has been found on *Phallus* sp. at Wad Medani, and several other Drosophilids occur in the country.

Milichiidae

Many larvae of *Leptometopa coquilletti* Hendel and of a species which is almost certainly *L. latipes* Meigen have often been found together in pit latrines. The two larvae, which are much smaller than those of *Musca*, can easily be distinguished from each other by some of the many features shown in detailed drawings of Sudan specimens by Hennig (1956). In *L. coquilletti* the anterior spiracles have short thick processes which project sideways, and the caudal region has an almost truncated appearance. In *L. latipes* long slender processes of the anterior spiracles point forward and the caudal region tapers towards the divergent spiracular lobes which give the larva a fork-tailed appearance. The puparia retain some of the larval characters and are rather like those shown by Bohart and Gressitt (1951) in their Plate 12, figures 2 and 1 respectively. That of *L. coquilletti* is grey and that of *L. latipes* reddish-brown. Larvae of the former were common in pit latrines in Khartoum North (Table I), Omdurman (A. A. M.) and Wad Medani, and possibly Port Sudan.

TABLE I.—*Larvae in samples from pit latrines near Khartoum**

Species	Percentage of pits in which larvae were found		Larvae per 1000 samples	
	Omdurman (1165 inspections)	Khartoum North (1303 inspections)	Omdurman (493 larvae)	Khartoum North (2734 larvae)
Diploneura cornuta (and others ?)	1·1	5·0	11	107
Eumerus obliquus	1·7	8·0	24	247
Musca domestica vicina (and others ?)	3·7	2·3	190	157
Leptometopa coquilletti (and others ?)	6·2	43·1	159	1302
L. latipes (and others ?)	2·8	19·4	70	384
Fly larvae	13·2	58·9	423	2098

* See discussion on p. 93.

L. latipes, a Palaearctic species, bred in pit latrines at Wad Medani, and similar larvae were found in the same type of breeding place in Khartoum North and Omdurman. An adult of a species of *Leptometopa* was found in a pit latrine at Mvolo.

Desmometopa singaporensis Kertesz, which occurs in many parts of the world (Becker, 1926), has been found in a septic tank at Khartoum and been bred from a pit latrine at Suakin and rotting cotton seed at Wad Medani.

Chloropidae

The synonymy of *Oscinella aharonii* Duda was discussed by Sabrosky (1949), and the mouth-parts of Khartoum specimens were examined by Graham-Smith (1930), who found them to be much like those of *Hippelates pusio* Loew. *O. aharonii* is common in the Sudan (Sabrosky, 1951), where it is known from Atbara, Kassala (troublesome in March, 1939), Es Semeih, Tebub and some other places in the Gezira where it was numerous in the winter of 1952–53, Wad Medani and elsewhere. Lewis (1954*b*) briefly described its habits and referred to Cottam's studies in Khartoum, where this fly was numerous from September to December. Its breeding places have not yet been found, although emergence traps were placed over cracked clay and damp soil in an infested

area. Records of the breeding habits of some other Chloropids (Roy, 1928 ; Herms, 1950 ; Burgess, 1951) suggest that the larvae of *O. aharonii* may occur in ploughed soil, or soil near stables, far from the area infested by the adults. Some species of Chloropidae assemble in large numbers (Barnes, 1933; Anonymous, 1941 ; Colyer and Hammond, 1951 ; Scott, 1951 ; Muirhead-Thomson, 1954), and several, including *O. aharonii*, cause annoyance by gathering inside houses. This species is sometimes abundant in parts of the Gezira Research Farm during the relatively cool dry period between October and April, clustering in immense numbers on banana leaves and elsewhere. Adults were once found in a hedge of Coral Creeper, but not in neighbouring plants, at Wad Medani, and were so numerous that when they were disturbed and flew out they felt like a solid object striking one's skin. In the late afternoon many were flying in a northerly or southerly direction at right angles to the rays of the setting sun. Only certain houses, generally near large trees, are liable to be infested, probably because they are near the particular shady vegetation in which the flies rest. They can easily be killed with pyrethrum spray, but were once very troublesome when millions penetrated the mosquito wire of an insectary where insecticides could not be used.

(c) *Schizophora Pupipara*

Hippoboscidae

Host specificity is not very pronounced in this family according to Bequaert (1930*b*), and, of the eight species of *Hippobosca*, which all occur in Africa, only *H. struthionis* Janson seems to be confined to one host and a few others on to which it strays. Bequaert points out that the distribution of *H. camelina* Leach, *H. equina* L., *H. longipennis* Fabricius and *H. variegata* Megerle von Mulhfeld is largely due to the spreading of their domestic hosts by man, and suggests that certain equines and cattle are attacked by more than one species of *Hippobosca* because the flies have thus extended beyond their original home.

H. camelina is known from Bara (Becker, 1923), Delami and desert areas generally (King, 1911), Dongola, Erkowit (bit man, Becker, 1923), Gedaref, Hamdab, Khor Hanoiet, Kassala, Khartoum, the Nubbaka-Umm Ramad area and El Obeid (Becker, 1923), Rera, Sennar (Becker, 1923), " the Sudan " (Balfour, 1906 ; Theobald, 1906), Summit and Tokar.

H. equina, which seems to be replaced by *H. variegata* in tropical Africa (Bequaert, 1930*b*), has been recorded from the Sudan by Balfour (1906), Theobald (1906) and Becker (1923), and has been reported to occur on Jebel Marra. *H. hirsuta* Austen, an Ethiopian parasite of large antelopes (Bequaert, 1930*b*), was found at Kelling.

The small *H. longipennis* F., the dog fly of the near and far east (Bequaert, 1930*b*), is known from Khor Arbaat (Bequaert, 1939), Argo, Berber (King, 1911), Debba, Erkowit, El Goleid, Hag Said, Khor Hanoiet, Kapoeta, Khartoum, Lugud (Bequaert, 1939), Port Sudan (King, 1911), Sinkat, Tokar, Wad Medani and Wadi Halfa. *H. struthionis* has been found in the Sudan and probably occurs wherever the ostrich does.

H. variegata, which occurs most commonly on domestic cattle and equines and is sometimes seen on camels (Bequaert, 1930*b*), has been taken at Delami, Deweina (on camel), Disa, an unspecified place in the eastern Sudan (Bigot,

1884), Erkowit, El Fasher, Gedaref, Ghulfan, Khor Hanoiet, Heiban, Kaka, Kapoete, Kateir, Khartoum, Khashm el Girba, at a place near Khuwei, Kebkabiya, Kosti, Khor Leira, Li Yubu, Malakal, Meshra er Req, Jebel Moya, Lake No, Rashad, Rejaf, Rera (Kassala Province), Roseires, Shambat, Suakin, Talodi, Tonga, Torit, Tubor, Wad en Nail, Wad Medani, Wau, Wong Thar and Zeidab. There are few records of it biting man (Bequaert, 1953) and it seldom does so in the Sudan although it often crawls on the human skin.

A species of *Echestypus* and one of *Lipoptena* have been recorded from the Sudan by Bequaert (1942). *Lynchia ardeae* Macq. has been found at Wad Medani and *L. pilosa* (Macq.) at Sennar, and two species of *Olfersia* were recorded by Becker (1923). *Ornithezia metallica* Schiner has been found at several places ; *Pseudolynchia canariensis* Macq., an important pest of pigeons in warm regions (Herms, 1950), is known from Abu Tubor, Agur, Beika, Delami, Goz Khadra (W. R.), Kajo Kaji, Murikurren (W. R.), El Obeid, Umm Dona, Wad Medani and Khor ez Zeraf, and *P. rufipes* Macq. has been found at Beika.

Nycteribiidae and Streblidae

Cyclopodia greeffi Karsch has been found on fruit bats at Jebel Lafon and Wad Medani, and a species of *Nycteribia* was recorded from the Sudan by Becker (1923). Two Streblids are known in the Sudan, *Nycteribosca africana* Walker from Khartoum (King, 1911) and the southern Sudan (Jobling, 1954) and *Tripselia amiculata* Speiser (*fryeri* Scott) from Yambro.

(d) *Schizophora Calypterae*

Tachinidae

Several species of *Oestrus* and other members of the Oestrini, subfamily Phasiinae, have been recorded from the Sudan. *Hypoderma corinnae* Crivelli was reported by Gedoelst (1919) and van Emden (1950) ; larvae of *Dermatoestrus antilopinus* (Brauer) were found in a Reed Buck at Pibor (J. F. E. B.), and a species was recorded by Gedoelst (1919). *Rhinoestrus hippopotami* Grünberg is probably widely distributed in tropical Africa and occurs in the Upper Nile (Bequaert, 1930*a*). *R. purpureus* Brauer, a parasite of horses and mules in the Palaearctic Region (Séguy, 1950), was recorded from Shendi by Gedoelst (1919) and from the Sudan by van Emden (1944). *Oestrus variolosus* Loew was recorded from the Sudan by King (1911), Rodhain and Bequaert (1915), Gedoelst (1919) and van Emden (1944). *O. compositus* Gedoelst, described as a larva and therefore possibly a synonym (van Emden, 1944), was recorded from the Sudan by Gedoelst (1916), and *O. regalis* Austen by Austen (1934).

O. ovis, the nearly cosmopolitan nasal bot fly of sheep (van Emden, 1944), is known from Khartoum (Becker, 1923 ; van Emden, 1944), Rabak (in goat, King, 1911) and Wad Medani.

Cephalopina titillator Clark (= *Cephalomyia maculata* Wiedemann according to Zumpt, 1951) was for a long time given the generic name of *Cephalopsis*, a name preoccupied by *Cephalopina*. This fly is a Palaearctic species which is found in a large part of the Mediterranean area and extends well into the Ethiopian Region, its distribution perhaps following approximately that of the genus *Camelus* (van Emden, 1944). In the Sudan it is known from Khor

Arbaat, Khor Balonai, Bara (perhaps a pale variety, Becker, 1923), Dungunab, Hag Abdullah, Kosti, Wad Medani and Zeidab.

Calliphoridae

The following notes are additional to records by Lewis (1955) of the known distribution of 48 species in the Sudan. *Sarcophaga haemorrhoidalis* Fallén was found at Delami and Zalingei, *S. tibialis* Macq. at Dueim, *S. destructor* Malloch at Shendi and Port Sudan, and *S. dux* Thomson (which occurs in Europe, the East and the Nearctic Region according to White and others, 1940) at Khartoum (1931, R. G. A.). *Thelychaeta dubiosa* Villeneuve was found at Lotti. Three females of *Rhynchomyia dubiosa* Villen. were seen at 5.50 p.m. in September at Wad Medani, digging backwards into a flower-bed and laying eggs. One made three shallow pits about a centimetre apart, and an egg was seen protruding from its abdomen before it entered one of the pits. Eggs, 2·1 mm. long and 0·7 mm. wide, were found in the pits and hatched within 24 hours. This species is known from Delami (bred from pupa in soil, W. R.), Madu (14° 36′ N., 26° 01′ E. many under bush in evening in July, 1930, A. P. G. M.) and Sennar. *Lucilia cuprina* Wied. was found at El Fasher, Guldo and Zalingei, *Auchmeromyia luteola* (Fabr.) at Kutum and *Cordylobia anthropophaga* (Blanchard) at Li Rangu (A. P. F.). *Hemigymnochaeta varia* (Hough) (a common east and south African species which has been bred from cow dung, according to Zumpt, 1953), occurs at Kelling.

Muscidae

Lewis (1954*a*) recorded 86 species from the Sudan, and the following are some additional notes on the family.

Musca: House-flies tend to be much more numerous in the north of the Sudan than in the south, probably because in the desert or semi-desert regions there are relatively few predators to destroy the larvae and few scavengers to compete for their food or cause it to dry up. Conditions may be somewhat comparable to those on Guam Island where Bohart and Gressit (1951 : 34, 35) attributed the abundance of flies to the scarcity of predators and considered the possibility of introducing certain beetles. The opposite situation is seen at Wad Medani in July and August, the first part of the short rainy season. In at least some years many coprophagous and predatory beetles appear at this time and house-flies are surprisingly scarce ; they then tend to increase as the rains proceed, to decrease in the relatively cold winter and, as in other areas (Whitehead and Crouch, 1926), to increase again about March, when the weather is warm but not yet very hot.

The annual reports of the Sudan Medical Service contain many references to the probable importance of house-flies as vectors of disease. In the central Sudan dysentery during or after the rains has been attributed to the multiplication of *Musca* at that time, and on the coast flies and dysentery increased in November and December, probably owing to high humidity because the average rainfall in those months, only 44 and 27 mm. respectively at Port Sudan, is unlikely to have affected breeding conditions materially. In the past transmission of typhoid in the Omdurman district, epidemic diarrhoea in children, yaws in the Upper Nile cattle camps, and eye diseases at Lafon have been attributed to *Musca*.

House-flies are difficult to control in some places. Resistance to several insecticides soon developed in Omdurman (Busvine, 1954), wood for roofing pit latrines is costly, and flies often travel for miles on people's backs so that many flies are often found in the absence of a breeding place. In rural areas most larvae in large masses of cow dung can be killed by the biothermic method if the dung is frequently turned over. Cotton seed and lucerne are available in many places and, when allowed to rot in water, make good bait for fly traps.

The following are records of some species:

M. cuthbertsoni Patton was bred from rotting cotton seed at Wad Medani, and *M. domestica vicina* Macq. (with *M. sorbens* Wied. and other flies mentioned below) from pupae collected in a mass of larval skins of *Ephydra riparia* Fallén and other debris on the salty shore of the shallow Deriba Lake in the crater of Jebel Marra, and from the paunch contents of a camel at El Hilla. Dwarf specimens of *M. sorbens* often annoy people by walking on the skin, and one such fly, taken on a sleeping man at Khartoum, was only about the size of a *Simulium*, with wings some 3 mm. long. *M. lusoria* Wied. was found on a cow at Wad en Nail, and *M. alpesa* Walker, which Dr. van Emden informs me is not, as previously stated, a synonym of *M. lusoria*, occurs at Fangak.

Stomoxys: Pupae of *Stomoxys calcitrans* (L.) were found on the shore of the Deriba Salt Lake, and this species and *S. nigra* Macq. were taken at Wad en Nail. E. T. M. Reid (1956) recorded the distribution of several species in the south.

Glossina: The annual reports of the Sudan Veterinary Service record the finding of three "islands" of *Glossina morsitans ugandensis* Vanderplank near the Jur narrows from which animal trypanosomiasis probably spread north along migration routes, and they note the beginning, in 1953, of the eviction of game to control tsetse in that area. Reid (1955) gives an account of of studies on *G. m. ugandensis* near the Jur narrows, and Buxton (1955) discussed many aspects of the tsetse problem in the Sudan.

Other genera: Ochromusca trifaria Bigot was found at Niertete. *Limnophora obsignata* Stein and *L. translucida* Stein were found at Kelling, and *Lispe loewi* Ringdahl, a Palaearctic species (Ringdahl, 1922), was found breeding on the shore of Deriba Lake.

III. Distribution

A considerable number of the flies mentioned are mainly Palaearctic in distribution and have spread into this northern part of the Ethiopian Region. Many of the flies which breed in refuse are more or less cosmopolitan species which have evidently been spread by man. Several of them, however, have apparently not penetrated beyond Khartoum, Port Sudan or Wadi Halfa, probably owing to the hot dry climate. Perhaps for the same reason most of the 26 species of Diptera listed by Séguy (1950 : 248) as cosmopolitan are rare or absent in the Sudan.

IV. The Dipterous Fauna of Pit Latrines

The following species have been found breeding in pit latrines in the Sudan: Psychodidae, *Telmatoscopus albipunctatus* (Williston) (Li Yubu, adults found which had almost certainly bred in pit); *Psychoda* sp. (Kala); Culicidae, *Culex cinereus* Theo. (in the south), *C. pipiens* L. (Omdurman), *C. p.* ssp.

fatigans Wied. (near the coast, Lewis, 1956*b*); Phoridae, *Diploneura cornuta* Bigot (Khartoum area) and *Megaselia* sp. (Suakin); Syrphidae, *Eumerus obliquus* Fabricius (Khartoum area); Calliphoridae, *Chrysomyia putoria* Wied. (Wad Medani, Gedaref, Kassala, Singa and many places to the south); Muscidae, *Musca domestica vicina* Macq. and *M. sorbens* Wied.; Milichiidae, *Leptometopa coquilletti* and *L. latipes*.

The importance of *Musca* is well known. *Ch. putoria* may contaminate food to some extent but none of the other species is known to do so. *Culex pipiens* and *C. p.* ssp. *fatigans* are annoying biters. Larvae of several flies may be mistaken for those of *Musca* during a cursory inspection of a pit. Larvae which, as mentioned below, can live in liquids, particularly the large larvae of *Eumerus* and the numerous larvae of *Leptometopa*, are believed to accelerate the liquefaction of the contents of pits and so make them unsuitable for house-fly larvae.

Table I shows the identifications, as far as possible, of larvae found in small samples of material taken from pit latrines in Omdurman and Khartoum North between November, 1939 and December, 1940. Omdurman, on the left bank of the Nile, is built on rocky ground, much of which is well above river level and the water table. Khartoum North, a few hundred yards away on the opposite bank and on the mouth of the Blue Nile, is situated on alluvial soil with a high water table. Except for larvae of *Musca*, which drown easily, those found were evidently able to live in liquids. Those of *D. cornuta* have hairy lobes which help to support them, and the others have a circle of hairs which surround the posterior spiracles and probably support them in water. *C. pipiens* sometimes occurred in pits near wadis. The contents of pits in Omdurman tended to be rather dry owing to the low water table, and, probably for this reason, larvae of *Musca* appeared to be relatively more numerous at Omdurman, those of the aquatic species being far more numerous at Khartoum North. As far as could be ascertained the adults of aquatic species did not frequent houses and it appeared that over 97 per cent. of the larvae found at Khartoum North produced adults which were either harmless or far less important than house-flies.

V. Myiasis

Myiasis is caused in the Sudan by some members of the following families: Tachinidae, species of *Oestrus* and other genera, on animals; Calliphoridae, many recorded examples of myiasis of men and domestic animals; Muscidae, larvae of *Passeromyia heterochaeta* (Villen.) attacking young birds; Trypaneidae, larvae vomited by man; Gasterophilidae, three species of *Gasterophilus* recorded. The Calliphorid, *Lucilia cuprina* Wied., a well-known cause of sheep strike in many countries, does not affect sheep in the Sudan, presumably because the weather is usually dry and the animals do not have thick coats which, as Herms (1950) points out, make them liable to be infested.

VI. Summary

This paper comprises records of many species of Diptera of medical interest and related forms, mainly in families other than the more important ones which have been dealt with in detail elsewhere; records of these latter have been brought up to date. The occurrence of certain species in pit latrines is discussed.

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VIII. References

Numerous publications dealing with Diptera in the Sudan are omitted from this paper and the following list, but most of them can be traced from the references given.

Abbott, P. H., 1950, A survey of signs of nutritional ill-health among the Azande of the southern Sudan. *Trans. R. Soc. trop. Med. Hyg.* **43** : 477–92.

Anonymous, 1941, [Abstract]. *Rev. appl. Ent.* (B) **29** : 134.

Austen, E. E., 1912, Notes on African blood-sucking midges. *Bull. ent. Res.* **3** : 99–108.

—— 1934, Two new Oestridae parasitic in African antelopes. *Ann. Mag. nat. Hist.* (10) **14** : 242–90.

Balfour, A., 1906, Biting and noxious insects other than mosquitoes. *Rep. Wellcome trop. Res. Lab.* **2** : 29–50.

—— 1909*a*, A new biting fly. *J. trop. Med.* (*Hyg.*) **6** : 79.

—— 1909*b*, Mosquitoes : with reference to immigration and horse sickness ; . . . *Cairo Sci. J.* **3** : 241–5.

—— 1910, Mosquitoes : with reference to immigration and horse sickness ; . . . *Lancet* **1910** : 100–1.

—— and Archibald, R. G., 1908, Review of some recent advances in tropical medicine. *Rep. Wellcome trop. Res. Lab.* **3** (Suppl.).

Barnes, H. F., 1933, Two further instances of flies swarming . . . *Ent. mon. Mag.* **69** : 230–2.

Becker, T., 1923, Diptera. Wiss. Ergeb. . . . Werner . . . Exped. . . . Sudan. VI. *Denkschr. Akad. Wiss. Wien* **98** : 57–82.

—— 1926, Ephydridae. *In* Lindner, *Flieg. Pal. Reg.* **56** : 1–115.

Bequaert, J., 1930*a*, Medical and veterinary entomology. *In* Strong, *Afr. Republ. Liberia* **2** : 797–1001.

—— 1930*b*, Notes on Hippoboscidae, 2. *Psyche, Camb., Mass.* **37** : 303–26.

—— 1939, Notes on Hippoboscidae, 13. *Ibid.* **46** : 70–90.

—— 1942, A monograph of the Melophaginae. *Ent. amer.* **22** : 1–172.

—— 1953, The Hippoboscidae or louse-flies (Diptera) of mammals and birds. Pt. I. . . . *Ibid.* **32, 33**.

Bezzi, M., 1915, *The Syrphidae of the Ethiopian Region.* London.

—— 1918, Two new Ethiopian Lonchaeidae, with notes on other species (Diptera). *Bull. ent. Res.* **9** : 241–2.

—— 1920, Further notes on Lonchaeidae (Dipt.). *Ibid.* **11** : 199–210.

Bigot, J. M. F., 1884, [Descriptions of Diptera from the Sudan]. *Ann. Soc. ent. Fr.* (6) **4**, lxix, lxxxix.

Bohart, G. E. and Gressitt, J. L., 1951, Filth-inhabiting flies of Guam. *Bull. Bishop Mus., Honolulu* **204**.

Brues, C. T., 1925, A Japanese *Dohrniphora* bred from dead snails (Diptera : Phoridae). *Psyche, Camb., Mass.* **32** : 313.

Brunetti, E., 1923, *Fauna Brit. India : Diptera.* Vol. III. *Pipunculidae, Syrphidae, Conopidae, Oestridae.* London.

Bryant, J., 1935, Endemic retino-choroiditis in the Anglo-Egyptian Sudan and its possible relationship to *Onchocerca volvulus. Trans. R. Soc. trop. Med. Hyg.* **28** : 523–32.

Burgess, R. W., 1951, The life history and breeding habits of the eye gnat, *Hippelates pusio* Loew, in the Coachalla Valley, Riverside County, California. *Amer. J. Hyg.* **53** : 164–77.

—— 1920, Further notes on Lonchaeidae (Dipt.). *Ibid.* **11** : 199–210.

Busvine, J. R., 1954, Houseflies resistant to a group of chlorinated hydrocarbon insecticides. *Nature, Lond.* **174** : 783–5.

Buxton, P. A., 1955, *The natural history of tsetse flies.* London.

Carpano, M., 1930, La peste equina con particulare riguardo a quella osservata in Egitto e in Eritrea. *Clin. vet. Milano* **58** : 325–41, 391–401, 471–84.

Coe, R. L., 1953, *Handbooks for the identification of British insects* **10** (1) *Diptera, Syrphidae.* London. Royal Entomological Society.

Colyer, C. N. and Hammond, C. O., 1951, *Flies of the British Isles.* London.

Cresson, E. T., 1939, Description of a new genus and ten new species of Ephydridae . . . *Notulae nat., Philad.* **21**.

Cruickshank, A., 1936, Tropical diseases of the southern Sudan : their distribution and significance. *E. Afr. med. J.* **13** : 172–7.

Curran, C. H., 1928, Diptera of the American Museum Congo Expedition. *Bull. Amer. Mus. nat. Hist.* **57** : 327–99.

Cuthbertson, A., 1936, Biological notes on some Diptera of Southern Rhodesia. *Occ. Pap. Rhod. Mus.* **1** (5) : 46–63.

Czerny, L., 1934, Lonchaeidae. *In* Lindner, *Flieg. Pal. Reg.* **43** : 1–40.

de Meillon, B. and Hardy, F., 1953, New records and species of biting insect-from the Ethiopian Region—IV. *J. ent. Soc. S. Afr.* **16** : 17–35.

Downes, J. A., 1955, The food habits and description of *Atrichopogon pollinivorus* sp. n. *Trans. R. ent. Soc. Lond.* **106** : 439–53.

du Toit, R. M., 1944, The transmission of blue-tongue and horse-sickness by *Culicoides. Onderstepoort J. vet. Sci.* **19** : 7–16.

Efflatoun, H. C., 1922, A monograph of Egyptian Diptera (Pt. I. Fam. Syrphidae). *Mém. Soc. ent. Égypte* **2** (1).

Forattini, O. P. and Lane, J., 1955, Sobre uma *Forcipomyia* que suga Phasmidae . . . *Rev. bras. Ent.* **4** : 1–6.

Freeman, P., 1956, A revision of the species of *Dixa* (Diptera : Culicidae) from Africa south of the Sahara. *Proc. R. ent. Soc. Lond.* (B) **25** : 163–70.

Gad, A. M., 1951, The head-capsule and mouth-parts in the Ceratopogonidae. *Bull. Soc. Fouad Ier Ent.* **35** : 17–75.

Gaud, J., Laurent, J. and Faure, P., 1956, Arthropodes vecteurs possibles de maladies au Maroc. *Maroc méd.* **35** : 1259–66.

Gedoelst, L., 1916, Notes sur les Oestrides. *Rev. Zool. afr.* **4** : 144–61.

—— 1919, Inventaire d'une collection d'Oestrides africains. *Bull. ent. Res.* **9** : 333–40.

Graham-Smith, G. S., 1930. The Oscinidae (Diptera) as vectors of conjunctivitis, and the antomy of their mouth parts. *Parasitology* **22** : 457–67.

Hafez, M., 1948, Ecological and biological observations on some coprophagous Sepsidae. *Proc. R. ent. Soc. Lond.* (A) **23** : 99–104.

Heiss, E. M., 1938, A classification of the larvae and puparia of the Syrphidae of Illinois exclusive of aquatic forms. *Univ. Ill. Bull.* **36** : 1–142.

Hennig, W., 1949, Sepsidae. *In* Lindner, *Flieg. Pal. Reg.* **39***a* : 1–91.
—— 1956, Beitrag zur Kenntnis der Milichiiden-Larven. *Beitr. Ent.* **6** : 138–45.
Herms, W. B., 1950, *Medical entomology.* New York.
Hinton, H. E., 1955, On the structure, function and distribution of the prolegs of the Panorpoidea, with a criticism of the Berlese-Imms theory. *Trans. R. ent. Soc. Lond.* **106** : 458–540.
Hodson, W. E. H., 1927, The bionomics of the lesser bulb-flies, *Eumerus strigatus* Fall. and *Eumerus tuberculatus* Rond., in South-west England. *Bull. ent. Res.* **17** : 373–84.
—— 1931, A comparison of the immature stages of *Eumerus tuberculatus* Rond. and *Syritta pipiens* Linn. *Ibid.* **22** : 55–58.
Howell, P. P., 1951, Notes on the Ngork Dinka of western Kordofan. *Sudan Notes* **32** : 239–93.
Jobling, B., 1954, Streblidae from the Belgian Congo, with a description of a new genus and three new species (Diptera). *Rev. Zool. Bot. afr.* **50** : 89–115.
Kamal, M., 1948, Biological studies of some midges and their relation to disease transmission, particularly the horse sickness. *Bull. Soc. Fouad Ier Ent.* **32** : 97–121.
Kieffer, J. J., 1921, Chironomides de l'Afrique équatoriale. *Ann. Soc. ent. Fr.* **90** : 1–56.
King, H. H., 1911, Report on economic entomology. *Rep. Wellcome trop. Res. Lab.* **4** : 95–150.
Kirk, R., 1956, African Leishmaniasis. *Centr. Afr. J. Med.* **2** : 199–203.
Lewis, D. J., 1952, Early travellers' accounts of surret flies (Tabanidae) in the Anglo-Egyptian Sudan. *Sudan Notes* **33** : 276–98.
—— 1953, The Tabanidae of the Anglo-Egyptian Sudan. *Bull. ent. Res.* **44** : 175–216.
—— 1954*a*, Muscidae of medical interest in the Anglo-Egyptian Sudan. *Ibid.* **45** : 783–96.
—— 1954*b*, Nimitti and some other small annoying flies in the Sudan. *Sudan Notes* **35** : 76–89.
—— 1955, Calliphoridae of medical interest in the Sudan. *Bull. Soc. ent. Egypte* **39** : 275–96.
—— 1956*a*, Notes on Simuliidae in the Sudan. *Ibid.* **40** : 109–18.
—— 1956*b*, The *Culex* mosquitoes of the Sudan. *Bull. ent. Res.* **47** : 707–21.
—— 1956*c*, Some mosquitoes of the Sudan. *Ibid.* **47** : 723–35.
—— 1957, Observations on Chironomidae at Khartoum. *Ibid.* **48** : 155–84.
—— and Kirk, R., 1954, Notes on Phlebotominae of the Anglo-Egyptian Sudan. *Ann. trop. Med. Parasit.* **48** : 33–45.
Macfie, J. W., 1947, Ceratopogonidae from the Anglo-Egyptian Sudan. *Proc. R. ent. Soc. Lond.* (B) **16** : 69–78.
Malloch, J. R., 1930, *Insects of Samoa* **6** (6) *Diptera Lonchaeidae*, pp. 239–51. London, British Museum (Nat. Hist.).
Muirhead-Thompson, R. C., 1954, The identity of " eye-flies " in Assam. *Ann. trop. Med. Parasit.* **48** : 121.
Neveu-Lemaire, 1938, *Traité d'entomologie médicale at vétérinaire.* Paris.
Oldroyd, H., 1952, *The horse-flies of the Ethiopian Region.* I. Haematopota *and* Hippocentrum. London.
—— 1954, *The horse-flies of the Ethiopian Region.* II. Tabanus *and related genera.* London.
—— 1957, *The horse-flies of the Ethiopian Region.* III. *Subfamilies Chrysopinae, Scepsidinae and Pangoniinae.* London.

PATTON, W. S., 1921, Notes on the myiasis-producing Diptera of man and animals. *Bull. ent. Res.* **12** : 239–61.
—— 1922, Notes on some Indian Aphiochaetae. *Indian J. med. Res.* **9** : 689–91.
—— 1931, *Insects, ticks, mites and venomous animals of medical and veterinary importance.* **2.** Liverpool.
PAUL, A., 1954, Some aspects of the Fung sultanate. *Sudan Notes* **35** : 17–31.
QUATE, C. W., 1952, A revision of the Psychodidae (Diptera) in America north of Mexico. *Univ. Calif. Publ. Ent.* **10** : 103–273.
REID, E. T. M., 1955, Some observations on *Glossina morsitans ugandensis* Vanderplank in the Sudan. *Acta trop. Basel* **12** : 193–221.
—— 1956, Notes on the distribution of Stomoxydinae (Diptera, Muscidae) in the southern Sudan. *Ent. mon. Mag.* **92** : 343–6.
—— 1957, Observations on Tabanidae (Diptera) in the Southern Sudan. *Ibid.* **93** : 76–81.
REID, J. A., 1953, Notes on house-flies and blow-flies in Malaya. *Bull. Inst. med. Res. F.M.S.* **7.**
RICHARDS, O. W., 1930, The British Species of Sphaerocoridae (Borboridae, Diptera). *Proc. zool. Soc. Lond.* **1930** : 261–345.
RINGDAHL, O., 1922, *Lispa litorea* Fall. und *pilosa* Loew. *Ent. Tidskr.* **43** : 76–77.
RODHAIN, J. and BEQUAERT, J., 1915, Sur quelques oestrides du Congo. *Bull. Soc. Path. exot.* **8** : 687–95.
ROY, D. N., 1928, A note on the breeding and habits of the eye-fly, *Siphonella funicola* Meij. *Indian med. Gaz.* **63** : 369–70.
SABROSKY, C. W., 1949, On the distribution and correct name of *Oscinis pallipes*, the swarming gnat of the Sudan. *Bull. ent. Res.* **46** : 61–62.
—— 1951, *Ruwenzori Expedition* 1934–35. *Chloropidae* **2** (7) : 711–828. London, British Museum (Nat. Hist.).
SCHMITZ, H., 1929, *Revision der Phoriden.* Berlin.
—— 1951, Phoridae. *In* Lindner, *Flieg. Pal. Reg.* **33** : 241–72.
SCOTT, H., 1951, Swarming of *Megaselia meconicera* Speiser (Dipt., Phoridae) in houses. *Ent. mon. Mag.* **87** : 269–70.
SÉGUY, E., 1928, Études sur les mouches parasites. I. *Encycl. ent.* (A) **9.**
—— 1950, La biologie des diptères. *Ibid.* (A) **26.**
SMART, J., 1956, *A handbook for the identification of insects of medical importance.* 3rd ed. London.
SOIKA, A. G., 1956, Contributions à l'étude de la faune entomologique du Ruanda-Urundi (Mission P. Basilewsky, 1953). CVII. Diptera Ephydridae. *Ann. Mus. Congo belge, Tervuren* 8vo. (*Sci. Zool.*) **51** : 490–505.
TAYLOR, F. H., 1938, Intermediary arthropod hosts and mechanical carriers of human disease in the Australian region. *Health, Melb.* **1938** : 1–5.
THEILER, A., 1921, African horse-sickness (*Pestis equinum*). *Sci. Bull. Dep. Agric. S. Afr.* **19.**
THEOBALD, F. V., 1906, Report on economic entomology. *Rep. Wellcome trop. Res. Lab.* **2** : 67–96.
THIENEMANN, A., 1954, *Die Binnengewässer* **20.** *Chironomus.* Stuttgart.
TONNOIR, A. L., 1939, *Ruwenzori Expedition,* 1934–35. *Psychodidae,* **1** (4) : 35–80. London, British Museum (Nat. Hist.).
VAN EMDEN, F., 1944, Keys to the Ethiopian Tachinidae. I. Phasiinae. *Proc. zool. Soc. Lond.* **114** : 389–436.
—— 1950, The identity of species of *Hypoderma* (Dipt.) attacking goat. *Bull. ent. Res.* **41** : 223–6.

VARLEY, G. C., 1948, A Ceratopogonid fly, *Palpomyia semifumosa* Goet. feeding on mayflies. *Ent. mon. Mag.* **84** : 36–38.

WHITE, R. S., AUBERTIN, D. and SMART, J., 1940, *Fauna of British India. Diptera* **6**. *Calliphoridae.* London.

WHITEHEAD, N. T. and CROUCH, H. A., 1926, Infectious jaundice in the Sudan. *J. trop. Med. Hyg.* **29** : 259–360.

WILLIAMS, A. J., 1913, Notes on an outbreak of horse-sickness connected with the presence of a *Lyperosia* as possible transmitter. *Vet. J.* **69** : 382–6.

WIRTH, W. W., 1956, New species and records of biting midges ectoparasitic on insects (Diptera, Heleidae). *Ann. ent. Soc. Amer.* **49** : 356–64.

WOODMAN, H., 1948, Filariasis in the southern Sudan. *E. Afr. med. J.* **25** : 45–104.

—— and BOKHARI, A., 1941, Studies on *Loa loa* and the first report of *Wuchereria bancrofti* in the Sudan. *Trans. R. Soc. trop. Med. Hyg.* **35** : 77–92.

ZUMPT, F., 1951, Myiasis in man and animals in Africa. *S. Afr. J. clin. Sci.* **2** : 38–69.

—— 1953, A preliminary contribution to the taxonomy of the genera *Hemigymnochaeta* and *Tricyclea* (Diptera : Calliphoridae). *Trans. R. ent. Soc. Lond.* **104** : 481–520.

—— and PATERSON, H. E., 1953, Studies on the family Gasterophilidae, with keys to the adults and maggots. *J. ent. Soc. S. Afr.* **16** : 59–72.